

The University of Chicago

RESPIRATION OF SOYBEAN
PLANTS IN RELATION TO LENGTH
OF DAILY PERIOD OF
ILLUMINATION

A DISSERTATION SUBMITTED TO THE
FACULTY OF THE DIVISION OF THE
BIOLOGICAL SCIENCES IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF BOTANY

1932

By

JOHN WILLIAM MITCHELL

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Introduction

Many plant physiologists have studied the responses of plants to different lengths of daily light exposure. The results of these investigations may be divided into three groups: first, those dealing with the effect of day length on the growth of plants; second, those considering the effect of day length on the chemical composition of plants; third, those investigations concerned with the effect of day length on the maturation of plants.

Garner and Allard (1) have shown that tobacco, beans, lettuce, and other plants grow larger when exposed to long light periods each day than when the plants are given short light exposures each day. Adams (2,3,4,5,6,7) studied the effect of different lengths of light exposure on the average weight and height of soybeans, tomatoes, corn, and many other kinds of plants. He found in general that plants which are exposed to longer light periods produce a greater average weight and height than those which are given short daily light exposures.

Tjebbes and Upholf (8) and Hostermann (9) were able to increase the growth of cereals by supplementing day light with electric light. Harrington (10) increased the growth of cereals during the winter by increasing the natural day length with artificial light.

The work of these investigators shows that the growth of most plants is influenced by the length of daily light exposure.

Garner, Bacon, and Allard (11) found that the acidity and form of carbohydrates in some plants was influenced by the length of the daily period of illumination. The actual acidity of those

plants adapted to short days increased when these plants were given long periods of illumination daily. They found an increase in the amount of polysaccharides in *Cosmos* within two days after the plants were transferred from a long to a short day. Nightingale (12) studied the effect of day length on the chemical composition of tomatoes, *Salvia*, and soybeans. He found that carbohydrates accumulate in these plants when they are grown in short days. The nitrogen metabolism of these plants was also found to be related to day length. Deats (13) found that the concentration of the cell sap in the leaves of some plants increased when the plants were grown in long days.

These investigations demonstrate that the chemical composition of some plants is influenced by the length of daily light exposure.

Garner and Allard (1,14) and Tinker (15,16,17) have shown that the time of flowering of some plants is affected by the length of the daily light exposure which the plants receive. They divide the plants which they studied, into three general groups, according to the effect of day length on the time of flowering. The first group includes those plants which are little affected in their time of flowering by the length of daily light exposure; the second group includes those plants which are caused to flower when grown in short days; and the third group includes those plants which are forced to flower when exposed to long days.

In general, these investigations show that the length of the daily illumination period has a marked affect on the growth, chemical composition, and the time of flowering of plants. The respiration and photosynthesis of plants is closely related to their growth, chemical composition, and their time of flowering. However, the fundamental processes of respiration and photosynthesis have not been studied in relation to plants grown in dif-

ferent day lengths. The experiments described in this paper were conducted in order to compare the respiration of plants grown in short daily periods of illumination to the respiration of plants grown under continuous illumination.

Experimental Material

Soybeans (Soja Max) of the Manchu variety were grown. This species of plant was selected, first, because it responds quickly to photoperiodic treatment. Second, it has leaves which are regular in outline and may be easily traced. Third, the soybean plant grows rapidly and can be placed in a small respiration chamber.

The seeds were germinated in quartz sand in two gallon glazed earthenware pots. Each pot contained six or seven plants. The pots were placed on two trucks when the plants were about three inches high. Two 1000 watt electric lamps were suspended over each truck four feet above the pots. The lights over one group of plants were automatically turned on at night. The plants on this truck were supplied with electric light during the night and full day light during the day. The plants on the other truck were given ten hours of day light each day. The remainder of the time they were kept in a dark room, the temperature of which was controlled with an electric fan and a heater. All of the plants were watered once a day with a complete nutrient solution. This nutrient solution contained KH_2PO_4 , $\text{Ca}(\text{NO}_3)_2$, MgSO_4 , and $(\text{NH}_4)_2\text{SO}_4$. Tap water was used to moisten the sand when necessary.

Apparatus

To measure the respiration of a plant a stream of air containing a known amount of carbon dioxide was passed over the plant and through an absorbing solution of N/10 sodium hydroxide. Changes in the concentration of carbon dioxide in the air stream were determined by means of the variations in the electrical con-

ductivity of the absorbing solution. The electrical conductivity of a N/10 sodium hydroxide solution decreases rapidly as the solution takes up carbon dioxide.

A diagram of the apparatus used is given in figure 1. The tank A was filled with two hundred and twenty cubic feet of compressed air, the carbon dioxide content of which was determined by the Winkler method. The flow of air from the tank was regulated with a needle valve. The air first passed through a coil, submerged in a constant temperature water bath, and then into the bottle B. This bottle contained one hundred cubic centimeters of Wesson oil. The temperature of the oil was controlled by the water bath. The mouth of the tube through which the air entered the bottle was about one half inch below the surface of the oil. Bubbles were formed in the oil as the air moved through the system. The rate of gas flow was determined by the number of bubbles formed in a unit of time.

The bottle was clamped rigidly into position during calibration of the apparatus. All connections were sealed with several coats of shellac and the temperature of the oil was brought to 25° C. Air was then passed through the bottle at the rate of one half cubic foot per hour. This rate of flow was obtained by displacing the air in a long graduated tube with water. The time was measured with a stop watch. It was found that 49 bubbles in exactly 30 seconds gave a rate of flow of one half cubic foot per hour. At this rate of flow the respiration chamber was emptied seven times each hour. The time required for the formation of 200 bubbles was determined a number of times to test the regularity of flow. The same time was required for the formation of each group of 200 bubbles. The apparatus was calibrated several times during its use. Each calibration showed that the same number of bubbles were required to give a rate of flow of one half cubic

FIGURE 2.

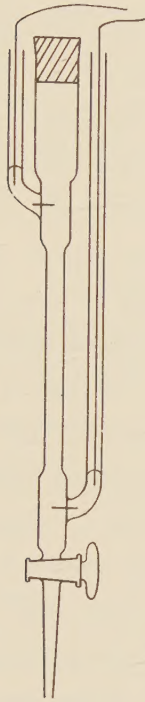
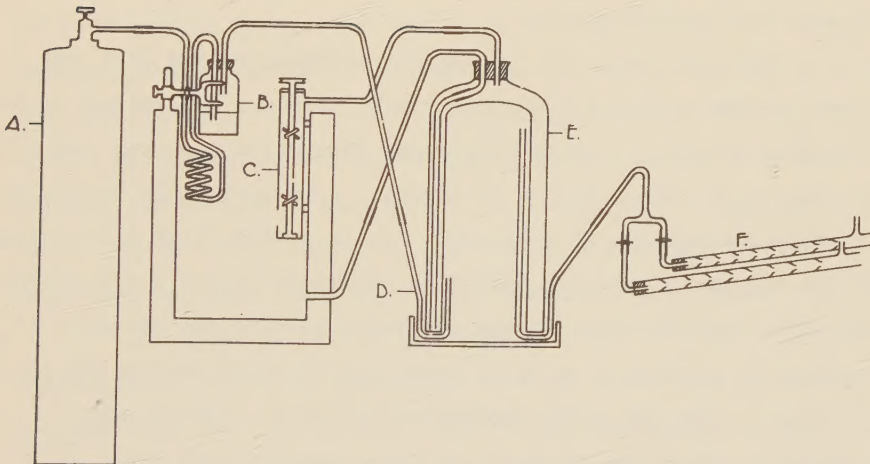


FIGURE 1.



foot of air per hour. The air stream passed from the bottle B, through the tube D, and into the double walled bell jar E. The bell jar was closed with a mercury seal. Water was circulated from the constant temperature bath through the double walled chamber of the bell jar by means of the pump C. The air inside of the bell jar was circulated by means of a small electric blower. Connections from the blower to the inside of the bell jar were made by passing glass tubes through the mercury seal. Air was drawn from the bell jar into the blower, and then, forced back into the bell jar rapidly enough to circulate the air about the plant. The temperature of the plant chamber was kept constant and the air inside of the bell jar thoroughly mixed in this way.

The air stream was conducted from the plant chamber through an absorption tube F. Two absorption tubes were constructed out of pyrex glass as shown in figure 1. They were arranged with rubber connections and clamps so that the air stream could be directed from one to the other with very little loss of time. The capacity of each absorption tube was 125 cubic centimeters. Air directed through a filled tube formed small bubbles as it passed through the eight chambers.

The efficiency of the absorption tubes filled with 125 cubic centimeters of approximately N/10 NaOH was determined in the following manner. A small additional absorption tube was connected to the end of the system to be tested. This small tube contained 25 cubic centimeters of N/10 NaOH. It is evident from a comparison of the volumes of the two hydroxide solutions that a given amount of carbon dioxide would change the resistance of the 25 cubic centimeter solution five times more than it would change the resistance of the 125 cubic centimeter solution. The 25 cubic centimeter hydroxide solution was approximately five times as sensitive to carbon dioxide as the 125 cubic centimeter hydroxide

solution. The apparatus was run for one half hour using air free from carbon dioxide and the increase in resistance of each solution was determined. The apparatus was then run for one half hour using air which contained carbon dioxide and the change in resistance of each hydroxide solution was measured. The results are shown in table I and are expressed in terms of milligrams of carbon dioxide equivalent to the increase in resistance of each solution.

TABLE I

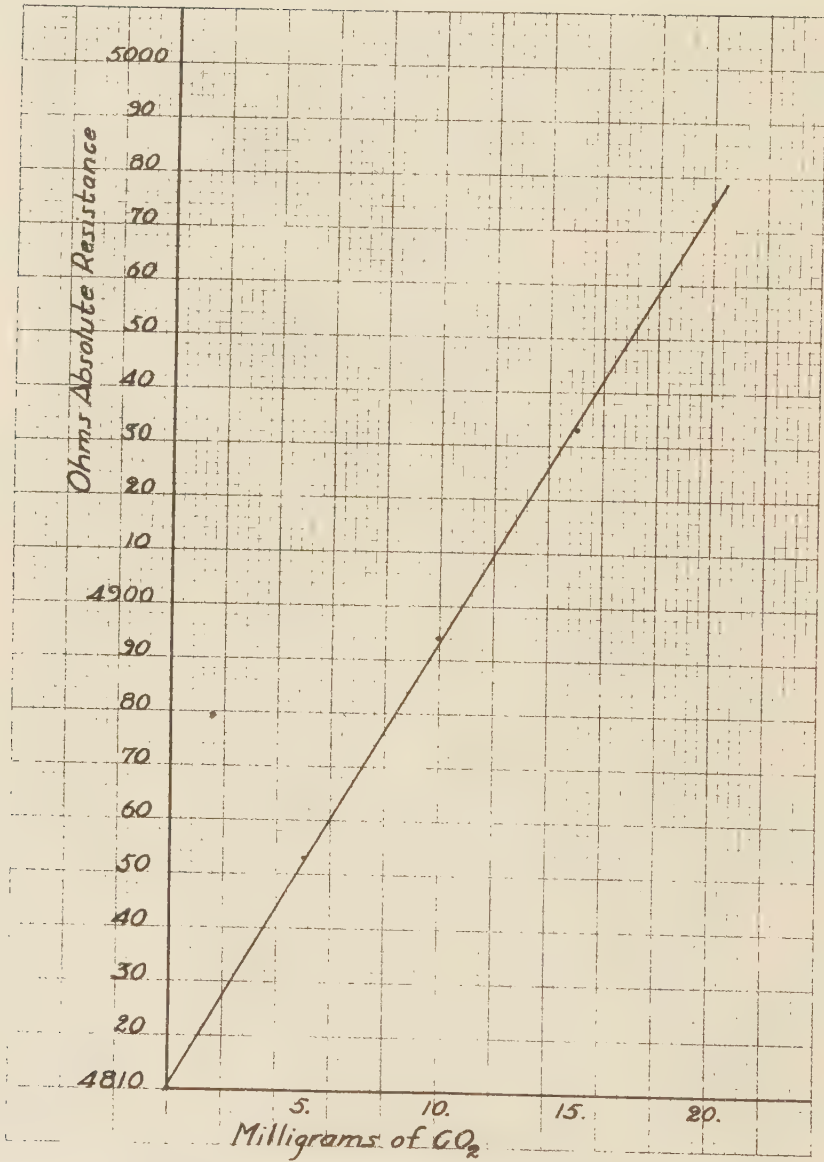
Increase in the Resistance of a 125 Cubic Centimeter and
a 25 Cubic Centimeter Solution of N/10 NaOH in
Terms of Milligrams of Carbon Dioxide

Solution	CO ₂ free air	CO ₂ in air	Time of run
125 cc. NaOH Solution	0.1 mgs.	4.95 mgs.	1/2 hour
25 cc. NaOH Solution	0.4 mgs.	0.4 mgs.	1/2 hour

The results show that the increase in the resistance of the 125 cubic centimeter solution was equivalent to 0.1 milligrams of carbon dioxide when one fourth of a cubic foot of air free from carbon dioxide had passed through the solution. The increase in the resistance of the 25 cubic centimeter solution was equivalent to 0.4 milligrams of carbon dioxide when one fourth of a cubic foot of air free from carbon dioxide had passed through the solution. These small changes in the resistance of the hydroxide solutions may have been due to the condensation of water.

The increase in the resistance of the 125 cubic centimeter hydroxide solution was equivalent to 4.95 milligrams of carbon dioxide when one fourth cubic foot of air containing an average amount of carbon dioxide was used. The increase in the resistance of the 25 cubic centimeter hydroxide solution was no greater when air containing an ordinary amount of carbon dioxide was used than

FIGURE 3.



when air free from carbon dioxide was used.

It is evident from these results that the amount of carbon dioxide which escaped from the absorbing solution was not sufficient to introduce a significant error.

The changes in carbon dioxide concentration of the air stream passing over the plant were small. It was necessary, for this reason, to use a dilute absorbing solution, and a conductivity cell of high resistance in order to obtain a method possessing the proper sensitivity. Figure 2 shows a diagram of the conductivity cell used. This cell had an observed resistance of 8,200 ohms when filled with N/10 KCl at 23° C.

A graph was prepared in the following manner for the purpose of reading the resistance of the absorbant in terms of milligrams of carbon dioxide. A known amount of air, which had been analyzed for carbon dioxide, was passed through the apparatus. The increase in the resistance of the absorbant was determined. The number of milligrams of carbon dioxide used was then plotted against the change in the resistance of the absorbant. Figure 3 shows such a curve which was plotted from the values given in table II.

TABLE II

The Increase in the Resistance of 125 Cubic Centimeters
of N/10 NaOH after Absorbing Different
Amounts of Carbon Dioxide

Mgs. of CO ₂	0.	5.	10.	15.	20.
Ohms Absolute Resistance	4810	4853	4894	4933	4975

Three different absorbing solutions of tenth normal sodium hydroxide were used during the course of these experiments. The absolute resistance of these solutions were: 4810, 4746, and 5139 ohms. A new curve was plotted for each solution as they were not

all of exactly the same concentration.

This method of measuring the concentration of carbon dioxide in an air stream is very sensitive. The average increase in the resistance of 125 cubic centimeters of the absorbing solutions was 41 ohms for every 5 milligrams of carbon dioxide. The resistance was determined accurately to 0.5 of an ohm. A difference of 0.5 of an ohm absolute resistance represents about 0.000062 of a gram of carbon dioxide.

Method

The following procedure was used in order to obtain comparable results when measuring the respiration of different plants. Several days before making a respiration measurement, the plant was transplanted from the larger pot into a small individual clay pot. Care was taken not to injure the plant and to eliminate all algae. The plant was placed under the two 1000 watt electric lights for twelve hours preceding the respiration measurements. It was then placed in the respiration chamber and the apparatus started. One hour was allowed to elapse to flush the system and to allow the rate of respiration of the plant to become adjusted. The carbon dioxide in the air stream was then collected in the absorbing solution for one hour. At the end of this time the air stream was directed into a fresh absorbing solution contained in another tube. The used solution was immediately placed in a 150 cubic centimeter Erlenmeyer flask which contained air free from carbon dioxide. The flask was stoppered tightly with a rubber stopper. The solution was brought to 25° C. in a water bath, the temperature of which did not vary more than 0.005 of a degree. The resistance of the solution was measured in the conductivity cell previously described.

The plant was removed from the respiration chamber following one or two readings. It was kept in the dark at room tempera-

ture if more respiration measurements were to be made. If no further measurements were desired, the leaves were removed from the petioles. They were placed in a weighing bottle and weighed. The leaves were then traced and finally dried at 80° C. The dry weight of the leaves was determined and the area of the leaf tracings were measured with the use of a planimeter.

Various methods have been used to measure the respiring tissue of a plant. The amount of carbon dioxide given off from a unit of living substance in a unit of time is the measurement of respiration. It is not possible, of course, to measure exact amounts of living substance. Kidd and West (18) and others used the dry weight of the tissues as a measurement of the living substance. Spoehr and McGee (19) measured the area of leaves used in their studies on respiration.

Many cells in mature stems respire relatively little carbon dioxide. These cells, however, make up a large part of the dry weight of the plant. In order to avoid this error only leaves were used to measure the respiring substance of the plant. Respiration measurements based on the area or dry weight of the leaves of a plant are by no means exact, but it is possible in this way to avoid including in the measurements large numbers of cells which respire very little.

Results based on the dry weight and area of the leaves of the plants used agreed closely. The results given in this paper are expressed in terms of milligrams of carbon dioxide respired by one hundred square centimeters of leaf surface in one hour.

Results

Different types of plants were produced by the two different light periods used. The plants exposed to ten hours of day light each day made relatively little vegetative growth. They grew about two feet high and produced flowers in thirty or forty

days. On the other hand, the plants exposed to day light supplemented with electric light produced a large amount of vegetative growth. Some of these plants were allowed to grow until they reached a height of over six feet. They were still growing rapidly when harvested. Fifteen consecutive crops of soybeans were grown during the spring and summer. There was no case in which a plant grown in continuous light formed flowers.

Table III gives the comparative dry weight in grams of plants grown in the two light periods.

TABLE III

Average Dry Weight in Grams, of Plants Grown in 10 Hours
of Day Light Each Day and in
Continuous Light

Plants Receiving 10 Hours of Light Daily			Plants Receiving Con- tinuous Light		Per cent Increase in Dry Weight between Continuous and Short Day Plants
Days	Number of Plants	Average Weight per Plant	Number of Plants	Average Weight per Plant	
18	21	0.19 gms.	14	0.32 gms.	68.4
32	14	0.75 gms.	7	1.55 gms.	106.6
66	14	3.45 gms.	7	10.70 gms.	210.8

It may be seen from these results that the plants which received continuous light produced more dry matter than the plants which received alternate periods of light and darkness. It would be expected that the slower growing plants, which received ten hours of light each day, would contain storage compounds such as nitrate and starch in greater quantities than the plants grown in continuous light.

Chemical analyses were made to determine the amount of

some of the storage compounds in the stems of these plants. The samples were ground very finely in a ball mill and dried at 80° C. The amide nitrogen was removed from a water extract with sulphuric acid and driven off as ammonia. Any ammonia present was also liberated by this process. The nitrate nitrogen was then distilled out of solution as ammonia in the presence of Devarda's alloy.

The starch and dextrin was extracted in hot water. Iodine was used to test for complete extraction. Saliva was used to digest the starch and iodine was used to test for complete digestion. The resulting maltose was hydrolyzed in a 2% hydrochloric acid solution.

Sugars were extracted in 80% alcohol and the extract cleared with neutral lead acetate. The reducing power of the sugar solutions was determined by the modified Shaffer - Hartman method described by Stiles, Peterson, and Fred (20). Results of the analysis of plants grown in day light supplemented with artificial light and of plants which received ten hours of day light each day are given in table IV.

TABLE IV

Results of Chemical Analyses of the Stems of Plants of Different Ages Grown in Continuous Light and Others which were given 10 Hours of Light Daily. The Results are Expressed on the Dry Weight

Type of Plant	Per cent Nitrate Nitrogen	Per cent Total Sugar	Per cent Starch & Dextrin	Total Water and Alcohol Soluble Carbohydrate
Ten Hours Light per Day 25-28 Days	0.37	1.07	1.22	2.29
Continuous Light 25-28 Days	0.17	1.16	1.40	2.56
Ten Hours Light per Day 42 Days	0.32	2.16	1.65	3.81
Continuous Light 42 Days	0.13	2.61	0.56	3.17

The plants grew rapidly in both light periods for twenty to twenty-five days. The starch content of plants grown in continuous light was slightly higher after twenty-eight days, than the starch content of plants the same age which received ten hours of light daily. The analyses, however, show that plants grown in both light conditions contained less soluble carbohydrate at the end of twenty-eight days than at the end of forty-two days. After thirty to forty days the growth of the plants receiving ten hours of light daily had decreased noticeably, but the plants receiving day light supplemented with electric light continued to grow. The starch content of plants, which received ten hours of light daily, was greater at the end of forty-two days than it was at the end of twenty-eight days. The starch content of plants grown in continuous light, on the other hand, was much less at the end of forty-two days than it was after twenty-eight days. The sugar content increased more rapidly with age, in plants grown in continuous light, than in plants grown in alternate periods of light and darkness. The amount of nitrate did not change appreciably as the plants matured.

These results show that six weeks old plants which had received ten hours of light daily made little vegetative growth and were able to accumulate some carbohydrates as starch. Plants grown in continuous light made considerable vegetative growth and apparently used most of the photosynthetic products in building new tissue.

A number of young and a number of more mature plants were selected from those which had received alternate periods of light and darkness. The young plants were between twenty-two and twenty-five days old while the more mature plants were between forty-one and sixty-two. The average respiration rate of the mature plants was found to be 4.0 milligrams of carbon dioxide

per hundred square centimeters of leaf per hour. The respiration of the young plants was 6.9 milligrams of carbon dioxide per hundred square centimeters of leaf per hour. The respiration of the mature plants was approximately 40% less than the respiration of the young plants. There was a correlation between the respiration and growth activity in bean plants which had received ten hours of light daily.

The growth rate of plants grown in continuous light did not decrease noticeably during the time they were allowed to grow. The respiration rates of some plants of different ages grown in continuous light were measured. The results are given in table V.

TABLE V

Respiration of Plants Grown in Continuous Light at Different Ages. The Respiration is Expressed in Milligrams of Carbon Dioxide Respired by 100 Square Centimeters of Leaf per Hour

Age in Days	18	19	26	27	29	34
Respiration	5.9 mgs.	5.1 mgs.	6.0 mgs.	4.8 mgs.	4.9 mgs.	5.9 mgs.

The respiration rate did not decrease in the plants grown in continuous light between the ages of 18 and 34 days. Plants grown in continuous light more than 34 days were too large to be placed in the respiration chamber. These results indicate that there is a correlation between growth and the respiration of soybeans.

A comparison was made of the respiration rate of young bean plants grown in day light supplemented with electric light and young plants which had been given ten hours of day light each day. The plants in both light treatments were growing rapidly when the measurements were made. The usual method of placing the plants under two 1000 watt electric lights for twelve hours was

followed. The plants were then placed in the respiration chamber. The respiration of the plants was measured after they had been in the chamber for one hour. The results of these measurements are given in table VI.

TABLE VI

Respiration, in Milligrams of Carbon Dioxide, of Young Plants which were given 10 Hours of Light Daily and of Other Young Plants Grown in Continuous Light

Plant	Young Plants 10 Hours of Light	Young Plants Continuous Light
1	6.2 mgs.	5.2 mgs.
2	6.9 "	5.0 "
3	6.9 "	5.9 "
4	7.4 "	6.0 "
5	6.9 "	4.8 "
Average	6.9 "	5.4 "

It was evident from daily observations, and from the increase in dry weight per plant, that the continuous light plants grew more rapidly than the plants receiving only ten hours of light each day. The young plants which had received ten hours of light daily respired more vigorously, after being in artificial light for twelve hours, than the plants grown in continuous light.

The growth and synthetic activity of a young plant receiving alternate periods of light and darkness may be greater during the period of illumination than the growth and synthetic activity of a young plant which has been grown under continuous illumination. For this reason, the respiration of the plants grown in alternate periods of light and darkness may be relatively high following a period of illumination. However, the total growth produced by the slower but continual activity of the

plants grown in continuous light was found to be much greater, than the total growth of the plants which received alternate periods of light and darkness.

It is of interest to know of any variations which might occur in the rate of respiration of different bean plants during a period of darkness. Consequently, the respiration of the following types of plants were measured: first, young plants which had received ten hours of day light each day; second, mature plants which had been grown under the same conditions; third, young plants which were grown in continuous light. Table VII gives the average respiration of three plants of each type after they had been exposed to twelve hours of electric light and also after they had been in darkness for a period of twelve hours.

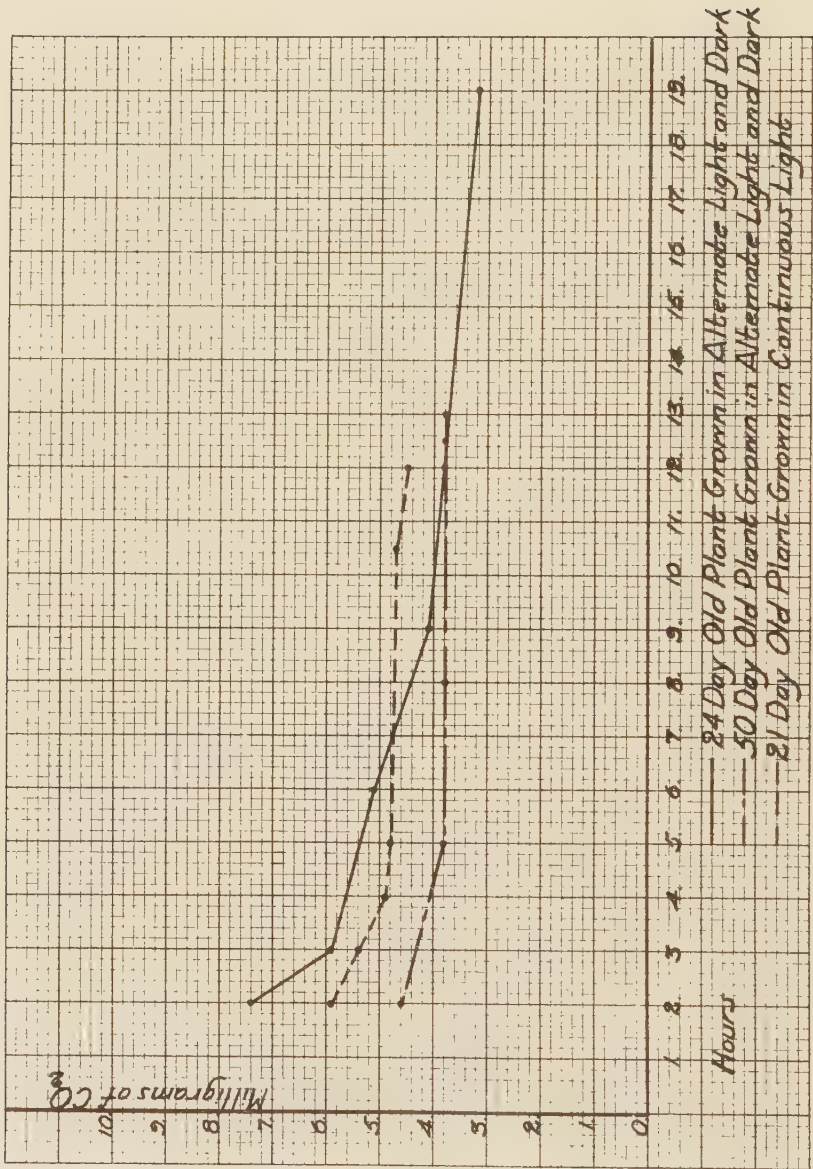
TABLE VII

Respiration of Young and More Mature Plants which Received 10 Hours of Light Each Day, and Also the Respiration of Young Plants Grown in Continuous Light. The Measurements Were Made at the End of 12 Hours Illumination and Again at the End of 12 Hours of Darkness

Type of Plant	CO ₂ out put After 12 Hours of Light	CO ₂ out put After 12 Hours of Darkness	Percentage Decrease
Mature Plants 10 Hours Light Daily	4.0 mgs.	3.2 mgs.	20. mgs.
Young Plants 10 Hours Light Daily	6.9 mgs.	2.7 mgs.	61. mgs.
Young Plants Continuous Light	5.3 mgs.	3.8 mgs.	28. mgs.

It may be seen that the respiration of the young plants which had received ten hours of light daily decreased sixty-one per cent during a twelve hour period of darkness. The respiration of older plants grown under the same conditions decreased only twenty per cent and that the continuous light plants twenty-eight per cent.

FIGURE 4.



In order to investigate the respiration of these three types of bean plants further, measurements were made at intervals during the twelve hour period of darkness. The plants were treated in the usual manner by placing them under two 1000 watt electric lights for twelve hours. They were then placed in the dark at room temperature and the respiration of each plant was measured at intervals. A graphical representation of the results is given in figure 4.

The young plant which had received ten hours of light daily respired the most per unit of leaf area following a twelve hour exposure to electric light. However, the respiration of this plant rapidly decreased. At the end of thirteen hours of darkness its respiration was less than that of the other two plants.

Discussion

A summary of the foregoing data shows that the respiration of a soybean plant, which has been exposed to ten hours of day light each day, is proportional to the growth of the plant. Young plants, which were growing vigorously, maintained a high rate of respiration, while older plants respired more slowly. The high rate of respiration found in young plants was apparently due to the active growth and synthetic activity they maintained.

Nicholas (21) found that young stems and leaves of Bryonia, Quercus, and other plants respired more rapidly than older stems and leaves of the same plants under like conditions. Hover and Gustafson (22) found that the respiration rates of the leaves of corn, sorghum, wheat, and oats decreased as the leaves grew older but as the leaves became still older (past about middle age) the rate gradually increased. They show, however, that the respiration rate of old leaves did not increase sufficiently with age to surpass the respiration rate of the younger leaves. Kidd and West (18) found the respiratory index of

Helianthus to be 3.00 when the plants were 4 days old. The respiratory index had decreased to 0.39 by the time the plants were 136 days old. They found a correlation between the growth rate of Helianthus and the respiratory index.

Hafenrichter (23), on the other hand, found that the rate of respiration of soybeans grown in the dark did not correspond to the growth rate. The fact that the plants he studied were starved for carbohydrates and grown in tap water may have caused an abnormal rate of respiration as well as an abnormal rate of growth. The results of the experiments conducted by Hafenrichter, although interesting, do not disprove the generally accepted idea that there is a correlation between the respiration rate of plants and their growth.

The respiration of soybeans grown in continuous light did not decrease between the ages of 18 and 34 days. The plants were growing rapidly during this time and continued to grow rapidly for several months until they were harvested. It was not possible to measure the respiration of very old plants grown in continuous light, as the size of these plants prevented placing them in the respiration chamber. A noticeable decrease in the respiration rate of the plants grown in continuous light would not be expected as long as vigorous vegetative growth was continued.

It is evident, from the data presented, that the respiration of young soybean plants grown in alternate periods of light and darkness was more intense, following a twelve hour period of artificial illumination, than the respiration under similar conditions of plants grown in continuous light. The intense respiration following a period of illumination of those plants which were accustomed to alternate periods of light and darkness would indicate relatively intense activity of the various life processes. The growth and synthetic activity of plants accustomed to alternate

periods of light and darkness may be greater during a period of illumination than the growth and synthetic activity of plants grown in continuous light. Measurements of the photosynthetic activity of plants grown in the two environments may give interesting information on this subject.

It has also been shown that there is a decrease in the rate of respiration of soybeans during a twelve hour period of darkness. The magnitude of the decrease in the rate of respiration during a period of darkness was found to depend upon the stage of maturity of the plant as well as the environmental conditions in which the plant was grown.

The respiration of young soybean plants which had received ten hours of day light each day decreased 61% during twelve hours of darkness. The respiration of more mature soybean plants which had been given the ten hours of day light each day decreased only 20% during twelve hours of darkness. The respiration of soybeans grown in continuous light decreased 28% during a twelve hour period of darkness. The variations in the rate of respiration of plants during a period of darkness is related to the amount and nature of the respirable compounds available. An explanation of the variations in the respiration of soybeans during a period of darkness should not be attempted until more is known about the nature and quantity of the respirable compounds which they contain.

Summary

1. The respiration of soybean plants, which have received ten hours of day light each day, corresponds to the growth of the plants.

2. The rate of respiration of soybean plants growing in continuous light does not decrease during the first month of growth.

3. The respiration of young soybean plants grown in

alternate periods of light and darkness is more intense following a period of illumination than the respiration of young plants grown in continuous light and measured under similar conditions.

4. Data are presented which indicate that the growth of soybean plants which are grown in alternate periods of light and darkness is greater during a period of illumination than the growth of similar plants grown in continuous light.

5. The rate of decrease in the rate of respiration of soybean plants during a period of darkness depends upon the degree of maturity of the plants and upon the amount of light the plants received daily during their growth.

The writer wishes to acknowledge his appreciation for the encouragement and helpful suggestions offered by Dr. C. A. Shull, Dr. E. J. Kraus, and Dr. S. T. Dexter, during this research.

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